

SAVANNAH RIVER ECOLOGY LABORATORY

ANNUAL TECHNICAL PROGRESS REPORT OF ECOLOGICAL RESEARCH FOR FY2009

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SAVANNAH RIVER ECOLOGY LABORATORY FY2009 OVERVIEW

The Savannah River Ecology Laboratory (SREL) is a research unit of The University of Georgia (UGA) that has been conducting ecological research on the Savannah River Site (SRS) near Aiken, South Carolina for over 55 years. The overall mission of the Laboratory is to acquire and communicate knowledge of ecological processes and principles. SREL conducts fundamental and applied ecological research, as well as education and outreach programs, under a Cooperative Agreement with the U.S. Department of Energy (DOE).

The Laboratory's research mission during the 2009 fiscal year was fulfilled with the publication of 28 journal articles and book chapters by faculty, technical staff, students, and visiting scientists. Three books were also authored by SREL faculty and staff members. Additional journal articles have been submitted or are in press. Significantly, SREL outreach activities reached over 29,000 people of all ages. Other noteworthy events took place as faculty members, staff, and graduate students received awards. These are described in the section titled Special Accomplishments of SREL Personnel.

FY09 was a year of continuing change in the vision, structure, and operations of SREL. Direct funding from DOE-EM (Environmental Management) ceased in FY07. Current funding from EM is based on individual projects and the specific needs of EM. These changes necessitated a conversion to programs that are entrepreneurial and interdisciplinary, and to funding strategies that are competitive, responsive to sponsors' requirements, and based on a diverse and sustainable foundation. This recognition required restructuring of research and supporting infrastructure, including downsizing of personnel and implementation of operational efficiencies.

Although these changes were very challenging, a reduced, but robust SREL presence continued to operate on the SRS in FY09. Currently, SREL's total employment is approximately 50 faculty, technicians, students, and support staff. This level of employees and funding is lean but ensures continued progress toward stated objectives and does not compromise safety and security. Some faculty members and laboratory work that is not site-specific to the SRS transitioned to the UGA main campus in Athens, Ga., while new partnerships and collaborations with the Athens campus departments and other agencies are being explored in order to fully use SREL assets. Graduate student programs have continued, with all costs paid by external grants, UGA, or the student's host university.

SREL faculty have responded to the revised structure and have sought financial support from external funding agencies, DOE-EM, DOE-NNSA (National Nuclear Security Administration), and SRNS-ACP (Savannah River Nuclear Solutions-Area Closure Projects, while UGA has provided temporary infrastructure support to SREL through this transitional period. A Cooperative Agreement with DOE allows SREL/UGA access to the SRS through 30 November 2011. Continued funding for SREL has been strongly supported by the local community for its role in research, environmental monitoring, and education/outreach programs for local schools and the general public.

Many challenges remain for SREL, including reorganizing research programs to address DOE and SRS-specific concerns, maintaining current research staff, and attracting new personnel. SREL researchers are also very vigorously pursuing additional funding sources to leverage existing research funds, while continuing to focus the laboratory's research efforts on projects of interest to the SRS.

Researchers at SREL had funding from 22 external grants during FY09. Sources of grant awards range from private foundations such as the National Fish and Wildlife Foundation to federal agencies such as the U.S. Department of Interior, the National Science Foundation, and the Department of Defense.

In addition to holding faculty positions in numerous departments at the University of Georgia, several SREL faculty members have adjunct status at other colleges and universities. Faculty, staff, and students also are active in providing outreach and service to the scientific community. Representatives from the laboratory hold editorial or committee positions in national groups and organizations and also serve on several UGA academic and administrative committees. SREL faculty members continue to make scientific presentations and contribute posters to scientific meetings, as well as present seminars at colleges and universities.

Participants in the SREL Education Program during FY09 included 3 undergraduate students and 13 graduate students from numerous colleges and universities in the United States. In the past year, 3 graduate students earned Doctor of Philosophy Degrees, while 2 students earned Masters Degrees for their research at SREL.

The SREL Outreach Program communicates scientific awareness to the general public, an audience which differs from science professionals. During the past year, SREL presented 269 talks, 18 tours, and 15 exhibits, reaching a total of over 29,000 people. Topics for these presentations included reptiles, amphibians, southeastern plants and habitats, long-term research, safety, biodiversity, local wetlands and watersheds, conservation, and careers in ecology and research.

The SREL Conference Center has continued to be a valuable asset to SREL and other groups on the SRS. SREL used the facility to host numerous meetings and environmental education programs for students, teachers, and other groups this past year. The facility is also used by DOE and the USDA Forest Service when it is available.

In July of 2009, Dr Stacey L. Lance was added to the SREL faculty. Dr. Lance is a molecular biologist and was previously employed as a post doctoral fellow. She currently manages the molecular genomics laboratory. SREL also lost two faculty members during FY09 as Dr. Chris Romanek left for a faculty position at the University of Kentucky and Dr. Tom Hinton left to become the Deputy Director of Radioecology and Ecotoxicology at the Institute of Radiation Protection and Nuclear Safety (IRSN) in France.

During FY09, the SREL faculty and staff were still adjusting to reduced funding and faculty and staff realignment. Many research programs were impacted, and in some instances may result in reduced reporting in this document, for example if the Principal Investigator is no longer employed by SREL.

SPECIAL ACCOMPLISHMENTS OF SREL PERSONNEL IN FY2009

John C. Seaman was elected Chairman of the Soil Chemistry Division of the Soil Science Society of America (SSSA), an international professional society with 6,000+ members. Responsibilities of the chairman include representing the division on the society's governing board, updating the division's website, and organizing the division's program for the SSSA's annual meeting scheduled for November 1-4, 2010, in Long Beach, CA.

Rebecca R. Sharitz served on the National Research Council (National Academy of Sciences) Committee on Water Resources Activities at the US Geological Survey, which produced the 2009 report entitled "Toward a Sustainable and Secure Water Future: A Leadership Role for the US Geological Survey". National Academy Press, Washington, DC, 114p.

BOOKS PUBLISHED

TURTLES: THE ANIMAL ANSWER GUIDE. 2009. **Whit Gibbons** and **Judy Greene**. Johns Hopkins University Press, Baltimore, MD. 163p.

LIZARDS AND CROCODILIANS OF THE SOUTHEAST. 2009. **Whit Gibbons**, **Judy Greene** and **Tony Mills**. UGA Press, Athens, GA. 235p. .

IDENTIFICATION MANUAL FOR TRADED TURTLES IN CHINA. 2009. Hai-Tao Shi, P.P. van Dijk, J. Parham, J. Fong, B. Horne, H. Zwartepoorte, C. Shaffer, J. Tucker, B. Devaux, A. Cadi, P. Prashag, G. Kuchling, T. McCormack, J. Iverson, H-D. Philippen, T. Blanck, G. Garcia, I. Das, P. Pritchard, **K. Buhlmann**, R. Mittermeier, J. Behler, A. Rhodin, A. Bertolero-Badenes, U. Fritz, and T. Diagne. Encyclopedia of China Publishing House (CIP), Hainan, China. 166p.

STUDENT AWARD

John D. Willson received the Society for the Study of Amphibians (SSAR) Siebert Award for the best student paper in ecology at the Joint Meeting of Ichthyologists and Herpetologists held in Portland, Oregon in July of 2009.

EDITORIAL BOARDS

Kurt A. Buhlmann served in editorial capacity for a number of scientific societies, including – Chelonian Conservation and Biology; Series Editor – Northwest PARC Habitat Management Guidelines; Series Editor - Habitat Management Guidelines for Amphibians and Reptiles of the Midwestern United States; Editor – PARC Inventory and Monitoring Techniques Manual; Editor – Conservation Biology of Tortoises and Freshwater Turtles. **J Vaun McArthur** was on the Editorial Boards of Applied and Environmental Microbiology and Journal of Environmental Management and Restoration. **Kenneth W. McLeod** was Subject Editor for Castanea. **John Seaman** served as Associate Editor for the Journal of Environmental Quality. **John D. Willson** was an Associate Editor for the Society for the Study of Amphibians and Reptiles.

SERVICE TO SCIENTIFIC SOCIETIES –

In addition to editorial service, several SRELians also served their societies in other capacities.

Kurt A. Buhlmann – Member of the Proposal Review Panel for the Linnaeus Fund; Executive Board Member for the Turtle Conservation Fund (TCF); Steering Committee Member – Turtle Survival Alliance; Member – National Steering Committee of Partners in Amphibian and Reptile Conservation.

Rebecca R. Sharitz – Member of the Executive Board of Audubon South Carolina and the Executive Committee of UGA Plant Biology Department

Tracey D. Tuberville – Member of the Florida Fish & Wildlife Conservation Commission; Co-Founder and Co-Chair of the Southeast Partners in Amphibian and Reptile Conservation Reintroduction Working Group; South Carolina State Representative to the Gopher Tortoise Council.

John D. Willson - Website Administrator for Partners in Amphibian and Reptile Conservation

OVERVIEW OF RESEARCH THEMES

Through a Cooperative Agreement between the Department of Energy and the University of Georgia Research Foundation, SREL provides an independent evaluation of the ecological effects of SRS operations through a program of ecological research, education, and public outreach. This program involves basic and applied environmental research, with emphasis upon expanding the understanding of ecological processes and principles, and upon evaluating the impacts of industrial and land use activities on the environment.

This is accomplished through a broad-based program of field and laboratory research conducted on the SRS and published in the peer-reviewed scientific literature; by providing education and research training for undergraduate and graduate students from colleges and universities throughout the United States and abroad; and by engaging in community outreach activities and service to professional organizations.

The FY09 SREL research plan responded to guidance from the DOE Site Manager to the SREL Director identifying DOE support for research in three critical areas:

- (1) *environmental characterization,*
- (2) *ecological risks and effects, and*
- (3) *remediation and restoration.*

Research at SREL addresses knowledge gaps in these areas by taking advantage of unique expertise in the environmental sciences and ecology, the unparalleled field research opportunities at the SRS, and the long-term data sets, research tools, and capabilities that SREL has developed over the last half-century.

ENVIRONMENTAL CHARACTERIZATION

Characterization is a necessary first step in determining environmental and health risks and in devising appropriate remediation and restoration strategies. Environmental information is also needed to make informed decisions about long-term stewardship and land management, and it is also a critical component of NEPA (National Environmental Policy Act) reports, Records of Decision (ROD), and other regulatory documents. Environmental characterization is more than simply measuring contaminant concentrations in biota or other media, or reporting the presence of organisms at various locations. It includes developing an understanding of the processes that control distributions of contaminants, chemical forms, and their bioavailability. Characterization is also necessary to construct models of how natural and engineered systems function, both in the presence and absence of environmental contamination.

Assessing the Ecological Health of Stream Systems and Watersheds of SRS Ecosystems: Modeling the Herptofaunal-Biodiversity Relationship

David Scott, Tracey Tuberville, William Hopkins, and Whit Gibbons

In recent years the Ash Plume Wetland (APW) and surrounding area in D-Area on the Savannah River Site (SRS) has been targeted for ecological studies due to the release of coal combustion wastes to the ecosystem several decades ago. High concentrations of trace metals (e.g., arsenic, selenium, and cadmium) in the waste may threaten the environmental health of the APW, especially for organisms such as amphibians that use both aquatic and terrestrial habitats during their life cycle. Our study builds on previous work by SREL scientists that examined the distribution of coal ash wastes in APW and the adjacent floodplain, as well as concentrations of metals in soil, plants, invertebrates, and amphibians.

Although trace element uptake and accumulation has been well documented in different species and life stages of amphibians at the APW, potential biological effects are not known. Earlier sampling of the amphibian and reptile community revealed that the assemblage of species at the site is similar to a nearby reference site (Ellenton Bay); i.e., the number of species found at the APW is comparable to the “expected” number. However, with the exception of the leopard frog (*Rana sphenoccephala*), newly metamorphosed individuals of amphibians were not found at the site in earlier studies, possibly indicating that the APW is not suitable for successful egg and larval development of some pond-breeding amphibians. If the APW is an ecological trap, rather than a source pond for many species, the lack of recruitment of juveniles into the population may be connected to the elevated trace metal concentrations.

We combined aquatic and drift fence sampling with artificial mesocosm pilot studies to 1) determine the species utilizing the APW and 2) begin assessment of the biological effects of the APW environment on pond-breeding amphibians. Due to funding delays, the study began in mid-March 2008, which was after most species had bred, laid eggs, and completed significant larval development. Nonetheless, we observed newly metamorphosed juveniles of two species (*R. sphenoccephala*, and the southern toad, *Bufo terrestris*). In contrast, five species produced juveniles at the reference site during the same time frame (additional species were the ornate chorus frog, *Pseudacris ornata*; the spring peeper, *P. crucifer*, and the tiger salamander, *Ambystoma tigrinum*).

In preparation for biological effects studies in FY09, we conducted pilot studies in artificial mesocosms in spring 2008. We used sediments from the APW and the reference site to establish APW and reference site aquatic treatments, in which we reared eggs and larvae of four species (*R. sphenoccephala*; *B. terrestris*; the southern chorus frog, *P. nigrita*; and the spadefoot toad, *Scaphiopus holbrookii*). In these pilot studies we did not observe any difference between the APW and reference site treatments on our response variables, egg and larval survival. In FY09 we plan similar, full-scale studies to assess effects of the APW environment on a wider array of species and a greater variety of response variables, such as embryonic and larval malformations, larval performance, and overall viability.

Update of the Wildlife Literature Survey (WLS) GIS Database

Charlie Davis

For FY09, the SRNS-ACP Group continued to fund SREL to update, enhance, and maintain a literature and GIS (Global Information System) database on SRS vertebrates (and 1 mollusk) of which 77 receptor species are recognized for use in SRS risk assessments and for incorporation into the IOU (Integrative Operative Unit) GIS project. As part of these updates, SREL collects and reviews publications, reports, theses, and dissertations and assembles records of all vertebrate (and 2 mollusk) species found in these documents. Specific site locations for the receptor species are then generated for inclusion into the WLS Excel and DBF database and ArcView GIS coverage.

SREL prepared and submitted only one update in FY09 - Version 19. Twenty-one publications were located including 11 SREL and 10 USFS-SR publications. The database spreadsheet was completed with 1174 new records being added for a total of 15,002 entries for 1195 publications. Approximately 400 polygon and 41 point shapefiles have been generated to date. This update had four wildlife species which did not have unique species ID # as a receptor identifier (see below list).

Sedge Wren (*Cistothorus platensis*)
Atlantic coast slimy salamander (*Plethodon chlorobryonis*)
Eastern Rat Snake (*Elaphe alleghaniensis*)
Upland Chorus frog (*Pseudacris feriarum*)

Database spreadsheets were provided in ArcView.dbf and Excel.xls formats. No shapefiles were created for this Version. Metadata for the WLS shapefile was updated and publication abstracts were created in html formats. The Update Version 19 was burned to CDs and provided to ACP.

The WLS and its GIS database continued to be funded as part of the ARRA funding for FY10 and FY11.

Deer Forage Habitat Assessment of Upper Steel Creek (USC) Area

Charlie Davis

In FY 2009, SREL produced a final report for the SRNS-ACP Group assessing the suitability of deer forage in the post industrial and recovering habitats of the Upper Steel Creek (USC) drainage. Historic discharges from P Reactor operations greatly modified the downstream environment and left radioactive contamination (Cs¹³⁷) in its floodplain and side slope

sediments. This legacy contamination is now a regulatory concern because white-tailed deer foraging on vegetation growing in these sediments may pose an ecological contaminant risk as well as a potential human health concern when hunters consume the meat.

The forage habitat assessment was done using Model III variables and standard sampling techniques from the USFWS Habitat Suitability Index (HSI) Model for the white-tailed deer. Transect and plot data were collected for seasonal use variables which focused on forage values of early spring/summer vegetation (herbaceous cover) and fall/winter vegetation (mast-bearing trees and shrubs). The two variables used to calculate HSI values were: percent cover of herbaceous plants/1m² plot (spring/summer forage; surrogate), and number of mast-bearing trees and shrubs per hectare. Photo interpretation analyses and field verifications were used to reconstruct pre-SRS and historical operation events within the drainage area to help explain where concentrations of radio-contaminants were deposited as well as mitigative efforts to slow erosion and downstream contaminant movement. A comprehensive GIS database was constructed for generating area statistics, vegetation and photo overlays, and figure illustrations. Based on this GIS database, approximately 44 % (17.4 ha; 43 acres) of the survey area was characterized as having been historically impacted from reactor discharge operations.

Assessment results determined that the forested habitats in the USC survey area have a relatively high forage suitability index for deer. These conclusions are based on averaged transect data and surrogate measures of seasonal food abundance and suitability of habitat use. In all three zones of disturbance and vegetation cover types and across all reaches, HSI values exceeded 1.0. Mean HSI for all reaches ranged from 1.18 to 1.39 across the three zones with the highly impacted riparian zone being the lowest of the three. However, if values for each seasonal variable are independently examined, with the exception of HSI values in two zones, across the board the forage suitability was less than optimal. This may suggest that while the habitat is utilized year round, seasonal use of the drainage may be limited. However, when combining mean HSI values and the availability of water and cover, it could be concluded that the USC survey area offers optimal forage habitat year round. In summary, the current forest vegetation found in the USC survey area provides the potential for a relatively high carrying capacity for white-tailed deer, both in terms of seasonal food abundance and cover.

Survey of Environmental Monitoring Techniques for Application to DOE Analysis and Monitoring Needs

Chris Romanek and John Seaman

The goal of this project is to evaluate existing analytical technologies that are presently being used in environmental and ecological initiatives at the Savannah River Ecology Laboratory (SREL) for potential application by DOE. Also, the co-investigators are performing experiments that use equipment at SREL to demonstrate the utility of these technologies, when applicable. Specific analytical needs were identified based on feedback from DOE personnel.

Foremost among the technologies under consideration are automated sensors that monitor the chemistry and isotope composition of various process gases. This project is closely aligned with ongoing testing of Cavity Ring Down spectroscopy (CRD) as a potential minimally invasive analytical technique for quantifying volatile materials containing various hydrogen isotopes, and other gaseous species (e.g., water vapor, O₂, NH₃, CH₄, etc.) that are critical to DOE operation.

A literature review was conducted to evaluate various techniques for extracting and analyzing tritium associated with biological tissues, such as vegetation in close proximity to DOE facilities. Flame oxidation followed by water vapor capture condensation represents the most appropriate method for isolating organically bound tritium for subsequent analysis by liquid scintillation. A series of laboratory investigations is underway to determine the isotopic hydrogen content of the organic fraction of environmental media from the Savannah River Site. Various soil cores and biological samples representing a range of tritium exposure histories have been archived for subsequent extraction using the flame oxidation method. Due to budgetary constraints, tritium extraction will be subcontracted to an external lab prior to analysis. Tritium extracts (i.e., tritiated water samples) will then be analyzed by liquid scintillation and CRD methods for comparison.

Cavity Ring Down Spectroscopy: Proof of Concept for Environmental Analysis and Monitoring of Process Systems at DOE's Savannah River Site

Chris Romanek and John Seaman

The goal of this project is to evaluate novel instrumentation that is currently available to detect and quantify the chemical composition of methane and ammonia in a carrier gas of variable composition (100% N₂ to H₂) as an analogue to DOE facility process gases. The co-investigators have identified one particular technology called Cavity Ring Down Spectroscopy (CRDS) as a viable tool that may meet the gas analysis needs of DOE. The co-investigators have discussed with two groups (Picarro and Los Gatos) the various spectroscopic analyses that can be made using the CRDS technique, and they purchased two off-the-shelf instruments: 1) a Picarro G1103 for the evaluation of trace ammonia (0 to 50 ppm) in a N₂-H₂ carrier stream, and 2) a Picarro G1202 for the evaluation of trace methane (0 to 50 ppm) in a N₂-H₂ carrier stream. The instrumentation is undergoing testing at the University of Kentucky to see that it meets specifications in ambient air. Once this is completed, the instruments will be rigorously tested for the chemical composition of trace analytes over a range of concentrations and carrier gas compositions. The results will be compared to conventional analyses performed by high precision gas source isotope ratio mass spectrometry and a report will be provided to DOE.

Improved Modeling of Inorganic Contaminant Transport in the Vadose Zone: A Defensible Basis for Monitored Natural Attenuation (MNA) and Enhanced Attenuation (EA)

J.C. Seaman and J.H. Singer

SRNL Collaborators: M. Denham and D.I. Kaplan

LBNL Collaborators: J. Wan and N. Spycher

Consistent with the DOE-EM mandate, the current project seeks to improve our understanding of contaminant fate and transport of contaminants (e.g., U and Cr) under physicochemical conditions that are both spatially and temporally variable at the field scale, focusing mainly on the EM-32 Applied Field Research Site (EM-AFRS). The "Vadose Zone" project leverages DOE resources through active collaboration between SREL, Lawrence Berkeley National Laboratory and SRNL. Such collaboration ensures that SREL research is aligned with DOE needs, while SRNL and LBNL benefit greatly from SREL's physical and chemical characterization of the SRS vadose zone and aquifer materials from the EM-AFRS.

The current project evaluates the utility of applying surface complexation modeling (SCM) in the prediction of contaminant fate and transport in the vadose zone (i.e., unsaturated zone). SCM has received considerable interest in recent years because of the potential to predict contaminant fate under transient chemical conditions that typically confound empirically-based modeling techniques. However, no studies evaluating the use of SCM to predict contaminant migration in the vadose zone where water content (θ) likely impacts partitioning through a number of coupled reactions have been published to date.

Extensive characterization of the reactive solid-phase is required to improve the mechanistic validity of SCM. Batch sorption and dynamic column experiments in conjunction with extensive solid-phase characterization, contaminant speciation, and reactive transport modeling are underway to evaluate the impact of variable θ on contaminant partitioning under leaching scenarios. Thirty-eight samples representing both the vadose zone and the water table aquifer at the AFRS were extensively characterized as an indication of 'reactive surface area' available for contaminant sorption, including qualitative/quantitative clay mineralogy. An additional 5 pre-fractionated clay samples submitted by LBNL were also characterized. Such information will be used in identifying bulk sediment materials for use in subsequent sorption experiments, and in evaluating the mechanistic validity of the resulting SCMs.

In November, the SREL PI participated in the 2009 EM22 Soil and Groundwater Remediation programmatic review, presenting a seminar summarizing the results to date. A draft report entitled "Clay Mineralogy of Sediment Cores collected from the EM-32 Applied Field Research Site" by J.C. Seaman, T. Murphy, and S. Walling was distributed to all collaborators in December, with an updated version submitted in January.

Support of the SRS Trophic Transfer Modeling Effort

L. Bryan

Significant effort has been expended by Savannah River National Laboratory (SRNL) and the Area Closure Project (ACP) group to develop model to assess ecological risk on DOE's Savannah River Site (SRS), including one contaminant exposure model to determine potential doses to endpoint receptor species (e.g.; river otter & belted kingfisher). The model evaluates risk within geographic areas according to their location in integrator operable units (IOUs). To date, this modeling effort has been hindered by a lack of data from some areas and erroneous data for some areas. Our task was to develop a database of appropriate data from historical and ongoing SREL studies, assist SRNL in integrating these data into the model, and identify data gaps to be resolved to more effectively assess risk within components of the various IOUs. A future phase of this project will include collections and analyses to close these data gaps, resulting in a more efficient model.

SREL has identified databases containing appropriate data from Tim's Branch, Fourmile Branch, Lower Three Runs, lower Steel Creek, and sites within the Savannah River Swamp System (SRSS) and is working to convert these databases into a format compatible to the SRNL model. The database for Tim's Branch, containing concentrations of multiple analytes in multiple species of biota (n=800+ individuals, total) from three projects, has been provided to ACP/SRNL.

ECOLOGICAL RISKS AND EFFECTS

Estimated risks and effects determine the need for remediation and restoration efforts, while perceived risks and effects determine the public's acceptance and support of DOE policies and actions. Estimating ecological risks and effects on the basis of sound science helps to ensure that good decisions are made by reducing uncertainties associated with complex environmental processes. A 1999 report from the National Academy of Sciences stated that *"Ecological risks are better characterized at the Savannah River Site than at any other DOE installation, due in part to the designation of the site as a National Environmental Research Park and the presence of the Savannah River Ecology Laboratory."*

Impact of Proposed MOX Facility Effluent Discharge to Upper Three Runs Creek Watershed

Gary Mills, Michele Harmon, and Ken McLeod

The Upper Three Runs Creek Stream Management Policy divides the stream into three regions: Region I is above the confluence of UTR and Tinker Creek, Region II is between this confluence and the confluence of Tim's Branch and UTR, and Region III is downstream of Tim's Branch to the Savannah River. Regulatory compliance with the management plan requires a sound scientific evaluation of the impact of the chemicals on the aquatic ecosystems within the UTR watershed. The goals of this study are to (1) determine the current water quality characteristics and copper concentrations of UTR and compare these values to a historical comprehensive database; (2) model the chemical speciation of Cu within the expected range of Cu concentrations and measured water quality parameters to predict Cu bioavailability; (3) directly test aquatic toxicity using a standardized bioassay; and (4) develop a site-specific biotic ligand model (BLM) and water effects ratio's (WER)s for UTR by linking dose-response data for Cu toxicity and geochemical Cu speciation data. Three sites, representing the three management regions have been sampled on a weekly basis for the past year. The site locations include: CCW30, northern sampling point located at bridge on Road 8-1; AEL, midpoint located at Aquatic Ecology Lab station off Road C; and UTR 3, a southern sampling point located at the bridge on Highway 125.

Temperature, pH, dissolved oxygen, and redox potential were measured in the field using portable probes. Samples for general water quality parameters were collected, and after returning to the lab, were analyzed for fluoride, chloride, bromide, nitrite, nitrate, phosphate, sulfate, and alkalinity. Samples for metal analysis were collected in separate ultraclean bottles and samples for dissolved organic carbon were collected in precleaned glass bottles. Dissolved copper values for 44 sampling weeks in the study region within Upper Three Runs ranged from 0.39 to 4.35 ppb. There was a slight increasing trend in concentrations from the upper to lower sites with means of 2.71, 2.94, and 3.72 ppb Cu for CCW30, AEL, and UTR3, respectively. Acute copper toxicity determined using a 48 hour bioassay with *Ceriodaphnia dubia* indicated a LC₅₀ (lethal concentration for 50% of test organisms) of 5.6 ppb for the AEL site compared with 6.03 for laboratory control water. Calculations of bioavailability using the EPA Biotic Ligand Model (BLM) are under way and the model predictions based on the measured water parameters will be compared with the daphnia toxicity data.

Environmental Protection of DOE Lands: Studies in Long-Term Stewardship

J Vaun McArthur, Rebecca R. Sharitz and John C. Morse (Clemson University)

In our original proposal we requested \$210K for the first year to complete the projects identified by U.S. Department of Energy (DOE) Environmental Management (EM) division for funding. EM provided an initial \$100,000 towards this project in December 2008. An additional \$68,000 was subsequently awarded but has been slow to be added to our financial plan. We were verbally informed of the possibility of receiving a second year allocation of \$150K and are awaiting final determination of those funds. We therefore report only those activities that were funded by the initial allocation of \$100K. This project covers two main sub-areas: (1) implementing a watershed approach to assess effects of ongoing and future industrial activities and effectively prepare for future missions, and (2) determining the effects of DOE operations on biodiversity.

Implementing a watershed approach - To implement a long-term approach to stewardship of the Savannah River Site (SRS), effects of site management practices must be understood in the context of other regional changes, such as long-term droughts and increased water usage in communities surrounding the SRS. Because of the limitation in the amount funded, we have chosen to begin our studies on the Upper Three Runs Creek (UTRC) watershed, which encompasses areas both on and off the SRS. We have acquired aerial imagery of the UTRC watershed and begun GIS evaluation of land-use changes over the last 40 years. In addition, we have assembled a database of historic water quality parameters from locations along UTRC and initiated additional sampling to evaluate changes in water quality that may be associated with off-site and on-site activities. We have made water collections corresponding to the sampling efforts described in the next section to compare with the historical water quality parameters. In subsequent years of funding, this effort will be extended to other SRS streams where extensive previous data exist.

Determining the effects of DOE operations on biodiversity - We have recruited Zachary Burington as a Masters student in Entomology at Clemson University. He will be supervised by Drs. John C. Morse and J Vaun McArthur. We have established sampling locations based on the historical sites used by Dr. Morse during his studies in the early 1970s. These sites include UTRC near the site boundary. This site had the highest reported aquatic insect richness of any stream in North America. Any impacts from site operations will be minimal at this location. The other sites include locations on Tinker Creek, Mill Creek and further downstream on UTRC. We have completed two sampling efforts to date with several thousand specimens separated into orders and awaiting species identification. Identifications will be performed by Mr. Burington. We will continue sampling every two weeks through November and then begin sampling again in early March. Dates chosen for collection correspond to the dates of the 1970 sampling plan. This will allow us to determine whether or not there has been a shift in biodiversity over the past thirty years. Our initial efforts will be to identify species of Ephemeroptera (mayflies), Trichoptera (caddisflies) and Plecoptera (stoneflies). These three orders of insects are among the most environmentally sensitive species and are excellent indicators of stream health. In subsequent years of funding as many of the other aquatic insects as possible that were captured in the traps will be similarly identified.

Baseline studies of water and soil quality, aquatic macroinvertebrate communities, and vegetation in an area adjacent to the MOX Fuel Fabrication Facility Construction Site

J V. McArthur, R. R. Sharitz, D. E. Fletcher, J. C. Seaman, E. A. Nelson(SRNL)

Construction of Plutonium Disposition Program (PDP) facilities on the SRS, including the Mixed Oxide (MOX) facility, may have unforeseen environmental consequences. According to an Environmental Impact Statement prepared for the MOX Fuel Fabrication Facility construction, no sedimentation or contamination was expected in the creeks that drain the industrial site. However, in June 2006 at least one storm event washed sand from the construction site down through an adjacent wetland slope onto the floodplain of a small stream (TRIB-1) which is a tributary of Upper Three Runs Creek (UTR) and into the stream itself. Sand deposits on the floodplain ranged up to two feet in depth. Sedimentation resulted in significant mortality of trees and other vegetation on the slope and floodplain, and was expected to affect water quality and macroinvertebrate biodiversity in the stream. Potential future effects, as the sediment load migrates downstream, are unknown and complicated by preexisting disturbances not associated with construction activities.

In order to assess the effects of the 2006 sedimentation event, we examined water chemistry and stream macroinvertebrate biota, and the continuing effects on wetland vegetation. Our preliminary results suggest that construction of the plutonium disposition program (PDP) facilities may have effects on ecosystems and ecological processes that were unforeseen by the EIS. Our results also indicate that TRIB-I adjacent to the MOX site has a long history of disturbance and had been significantly altered prior to construction activities. Given that the MOX facility is the first of three major PDP construction projects to be built in this drainage, and given the environmental sensitivity of this area, we propose that broader preconstructional/postconstructional and preoperational baseline surveys of soils, vegetation, and stream chemistry, hydrology, geomorphology, and biota in areas adjacent to the MOX site would be a good environmental stewardship action for DOE/NNSA to support. These studies should focus on the underlying causes of the observed perturbations.

I. SURVEY OF STREAMS, SPRINGS, AND WETLAND SEEPS ADJACENT TO THE PDP CONSTRUCTION SITE—Field surveys, remote sensing analyses, and literature surveys were performed to establish the pre-operating condition of the area adjacent to the PDP facilities. This effort was made in conjunction with the ongoing SRS Stream Condition Survey/Stream Mitigation Bank Project being conducted by C. Barton, University of Kentucky, D. Fletcher, SREL, and J. Blake USDA Forest Service.

II. PRELIMINARY EVALUATION OF WATER AND SOIL QUALITY IN SEEPAGE AREAS ALONG UTR AND TRIB-I — In April 2009 two stream gauging stations were established in the vicinity of the MOX facility, one within TRIB-I and the second within a nearby reference stream (U-10) to estimate water discharge and sediment loading during base flow and episodic storm events. Each gauging station consists of both a manual depth gauge and an automated water level sensor. Several manual stream profiles were collected in an effort to relate stream depth to water discharge (Q). Unfortunately, the reference stream is too shallow and diffuse to permit accurate velocity readings. In August 2009, stream water samples were collected at various locations along TRIB-I and the reference stream.

III. EVALUATION OF THE AQUATIC INVERTEBRATE COMMUNITY IN UTR AND TRIB-I —

We established four sampling locations: two on UTR and one each in TRIB-I below the MOX facility and the reference stream (control, U-10, see previous section). These sites were chosen to determine if there was an effect on the species composition due to sedimentation.

These first four sampling efforts have established that there are differences in the biological quality of TRIB-I compared to the reference stream and to UTR. In the second year of this study we will continue our monthly placement and retrieval of the multiplate samplers. We will measure biomass of the EPT (Ephemeroptera, Plecoptera and Trichoptera) and obtain more fine-tuned taxonomic resolution. The processing or decomposition of terrestrially derived organic matter provides most of the energy base for all streams on the SRS. We will perform leaf decomposition studies this fall to contrast predicted differences in the rates between the reference stream and TRIB-I. Such observations will provide information on system level processes in addition to our population-based observations such as density and richness.

IV. EVALUATION OF THE VEGETATION IN AREAS ALONG UTR AND TRIB-I ADJACENT TO THE MOX SITE—

In August 2006, two months after the sedimentation event, dead trees in the seepage slope adjacent to the MOX construction site were recorded by species and stem diameter (E. A. Nelson, pers. com.). Continued movement of sand in the seepage and stream floodplain areas is causing continued tree mortality and changes in the plant communities of these areas.

We sampled the vegetation during the spring and summer of 2009. In 10 m x 10 m plots, all trees and saplings greater than 1.4 m in height were identified to species and measured for girth (diameter at breast height, DBH). Within each plot, we established two 2 m x 2 m subplots at random locations for sampling herb (<30cm) and shrub (30-140cm) layer vegetation. We recorded canopy openness above each subplot in August using a spherical densiometer.

The main impact area, and to a lesser degree, the adjacent floodplain of TRIB-1, had heavy tree mortality. Mortality was disproportionate across species, with some species such as tulip poplar and redbay having very high mortality rates, and other species such as blackgum and sweetgum having lower mortality. Seedlings in all areas do not closely resemble the canopy vegetation, but shrub-layer composition and saplings in the heavy impact area indicate that canopy species, including the former dominant, tulip poplar, are regenerating. Thus the forest may gradually recover much of its original composition, and this recovery should be documented. Higher light conditions have promoted significantly different herbaceous vegetation, although it is expected that many of these species will lessen in importance as woody vegetation recovers. Downstream in the floodplain of TRIB-1, tree mortality, especially of tulip poplar, is still occurring, as the sand continues to move through this area.

REMEDATION AND RESTORATION

The knowledge and expertise based at SREL are ideally suited to address the remediation and restoration of large land areas contaminated with relatively low levels of metals, organics, and radionuclides. SREL conducts multidisciplinary research designed to assist in the development, evaluation and stakeholder acceptance of remediation and restoration efforts that protect human and ecosystem health. Fundamental to the success of various bioremediation, natural attenuation, and *in situ* remediation applications is an understanding of the underlying scientific principles on which they are based.

Continued Research at the Mixed Waste Management Facility

Julian H. Singer and John C. Seaman

In support of remediation efforts at the Mixed Waste Management Facility (MWMF), SREL continued working in collaboration with the DOE, USDA Forest Service (D. Strawbridge), and ACP (M. Kasraii) to assist with site management and provide the evapotranspiration efficiency estimates required for the Corrective Action Report (CAR). SREL representatives met with the MWMF management team on a regular basis to coordinate all activities, and maintain, update and report the results from the 1D tritium efficiency model originally developed by researchers from Cornell (Drs. K. Rebel and S. Riha). Efforts in FY 2009 focused on collecting and analyzing two sets of bi-annual soil cores. Twelve 3-meter cores (6 soil cores/report) were analyzed for soil physical properties and tritium concentrations in preparation for the 2008 end-of-year corrective action report (CAR) and 2009 mid-year report.

The 2008 end-of-year report for the CAR and the 2009 mid-year report to ACP also included the Cornell Model estimates of tritium use efficiencies and mass balance tritium use efficiencies based on data collected through 2008 and August 2009, respectively. Remediation efficiencies for the MWMF were calculated based on irrigation schedules, climate data, and soil core analysis from select plots within the facility since operation began in 2001. The lab results for document control and the 2008 CAR report documenting the soil tritium data, evapotranspiration efficiency estimates, and updated results from the Cornell model were provided to ACP in February 2009. The 2009 mid-year report and associated lab analyses were completed and transferred to ACP in October of 2009. Additional soil cores were taken in plots not regularly monitored for comparison with plots routinely included in the CAR. These cores were analyzed in a similar fashion to those from the regularly monitored plots.

SREL continued assisting the USDA Forest Service in updating the irrigation system and automating various monitoring system components, including the installation of electronic flow meters to monitor application rates for each irrigation plot. Also, pond recharge rates were calculated using continuous depth gauge measurements, the results of which were provided to USFS and ACP. SREL provided automated weather data collected at MWMF for use in the water deficit calculations performed by USFS personnel. Work integrating automated data collection into daily management of MWMF procedures is ongoing.

SREL provided assistance with the development of the eastern expansion of MWMF phytoremediation efforts on 12 additional irrigated plots. Monitoring plans similar to current sampling at the existing facility were developed and included in the plot layouts for the facility. Sampling for pre-irrigation site conditions was initiated in 2009 and is ongoing.

SREL researchers continue the development and calibration of an alternate 1-D model for describing tritium uptake by vegetation and downward movement through the soil profile based on the HYDRUS-1D code developed by researchers at the USDA. HYDRUS-1D is a one-dimensional finite element model that uses Richards equation to describe unsaturated/saturated water flow and Fickian based advection-dispersion equations to simulate the movement of heat and solutes in variably saturated, layered heterogeneous media under various boundary conditions. HYDRUS-1D provides a more mechanistic description of water movement through the soil profile when compared to the Cornell model. Current modeling efforts focus on evaluating the impact of various irrigation management strategies on tritium uptake efficiencies throughout the remediation lifetime of the irrigation facility.

In Situ Chemical Oxidation (ISCO) to Address Residual TCE and PCE Contamination on the SRS

J.C Seaman, G. Mills and T. Murphy

SREL has been collaborating with SRNS-ACP (Casey Knapp et al.), and Redox Tech, Inc. (Dr. J. Rossabi and G. Powers) since 2007 to design, permit, and conduct a field-scale evaluation demonstrating the utility of *In-Situ Chemical Oxidation*, commonly known as ISCO, to address residual volatile organic compound (VOC) contamination, i.e., trichloroethylene (TCE) and perchloroethylene (PCE), without the potential to form hazardous vinyl-chloride. SREL conducted a series of preliminary batch experiments that confirmed the ability of the preferred chemical oxidant, persulfate, to fully degrade TCE and PCE without the addition of a chemical catalyst, presumably due to the high Fe oxide content found in SRS aquifer sediments. Based on preliminary groundwater modeling efforts, a central injection well surrounded by 3 multiple-depth monitoring wells were installed to create the M-Area Chemical Oxidation (MACO) site. SREL designed and assembled the QED Inc. custom monitoring well components for the technical demonstration, and assisted SRNS in their installation in the monitoring wells (wells MOP1, MOP2, and MOP3). SREL assisted ACP in preliminary groundwater sampling at the site to establish background conditions prior to oxidation treatment and to become familiar with relevant sampling equipment/protocols.

A preliminary injection study conducted using clean water to evaluate the ability of the injection well (MIP-1C) to accept the oxidant solution indicated that the duration of the study would need to be extended to reflect the limited conductivity of the formation. Furthermore, logistical concerns (i.e., pre-job briefings, safety reviews, etc.) and heavy rainfall delayed persulfate injection until December 10th, with ≈1000 gallons of persulfate injected on both December 10th and 11th. Field activities were suspended for the weekend, and continued injection was further delayed by inclement weather on December 14th and 15th. Persulfate injection resumed on December 16th, with ≈1000 gallons of reactive solution injected on both December 16th and 17th. As before, injection was cancelled for December 18th due to inclement weather and then suspended for the weekend (December 19th and 20th). The remaining treatment solution (≈800 gallons) was injected on December 21st. Water level data from pressure transducers installed within each of the MACO wells was downloaded on December 15th. Throughout injection, SREL representatives were onsite to observe and assist Redox Tech and ACP as needed. Additionally, SREL sampled each of the three MACO site monitoring wells (MOP1, MOP2, and MOP3) at least once during each day of active injection. Wells MOP1 and MOP2 were divided into two screened zones/depths which were sampled independently, yielding four discrete

samples. Since injection was completed, SREL continued to sample the monitoring wells on a daily basis through the end of the year.

Persulfate breakthrough, as indicated by groundwater trends in Oxidation Reduction Potential (ORP) and electrical conductivity (EC), and the degradation of VOCs was limited to both sampling depths within the closest well, MOP1 (i.e., MOP1BU and MOP1C). TCE levels within well MOP1 were \approx 6-7 ppm before persulfate injection, and have remained consistently below 1 ppm since persulfate for several months. Although quite variable, TCE levels in the remaining monitoring wells have approached 40 ppm and generally remained above 5 ppm for the duration of the field demonstration, with little evidence of persulfate or reactive product (i.e., EC, ORP, sulfate, etc.) breakthrough. A set of column experiments using sediments similar to the MACO site indicated that the limited persulfate breakthrough observed in the field may be due in part to the high degree of retardation observed for the Fe oxide rich sediments.

H-02 Constructed Wetland Studies

Gary Mills, Elizabeth Burgess and Ken McLeod

The efficiency of constructed wetlands in removing metal contaminants from influent waters may vary with seasonal variations in environmental conditions, fluctuations in metal concentrations or chemical species, as well as in the biogeochemical status of newly constructed wetlands during progression toward a mature ecological state. These fluctuations in wetland metal removal efficiency may delay obtaining regulatory permitting for operation. The H-02 wetland was designed for treating effluents from multiple sources associated with the Tritium Facility at the DOE-Savannah River Site. Sampling of wetland surface waters and sediments began in August 2007 shortly after construction was completed. The objective of this study is to determine changes in biogeochemical parameters as the system progresses to a mature, steady-state system. The focus of this presentation is on general water chemistry and Cu in surface waters during the first year of the H-02 wetland development. Influent Cu concentrations ranged from 14.4-40.0 ppb with a mean of 25.7 ppb. Effluent concentrations varied considerably ranging from 4.24 to 40.0 ppb and, generally, progressively decreased during the first year. Copper removal was initially low (12%) then increased to an average of 36% through March 2008. Copper removal efficiency was consistently high averaging 80% during April–July 2008. Dissolved organic carbon (DOC) concentrations were initially low and generally ranged from 1-2 ppm through February 2008. DOC increased markedly from May-August 2008 ranging from 5.0 -8.4 ppm, concomitant with the increased growth of wetland vegetation. The increase in DOC likely contributed significantly to the complexation of Cu and the consequent reduction observed in the Cu toxicity of wetland water using *C. dubia* bioassays. Measurement of organically bound Cu using solid phase extraction methodology is currently underway. This constructed wetland is also responsible for ameliorating problems with high and variable pH values of water flowing from the retention basin, so that effluent waters more closely match the pH of the Upper Three Runs stream system.

H-02 Constructed Wetland Studies: Amphibians and Plants

David Scott, Tracey Tuberville, Rebecca Sharitz, Paul Stankus, Linda Lee, Matt Erickson, and Brian Metts

The Savannah River Ecology Laboratory (SREL) initiated amphibian and vegetation surveys at the H-02 constructed treatment wetlands in May 2008. Copper (Cu) concentrations in the H-02 system can vary spatially throughout the system, ranging as high as 31-37 ppb in the influent in

summer months to 7 ppb in the effluent exiting the treatment wetlands. Levels in portions of the retention pond have reached 340-590 ppb. These concentrations may be of concern for normal amphibian development. The ecological research conducted by SREL at the site focuses primarily on four questions related to these treatment wetlands: 1) Over time, what amphibians, reptiles, and plants have become established in the wetlands? 2) Is there any evidence that elevated trace metal levels (e.g., copper and zinc) in the wetlands affect amphibian reproductive and recruitment success? 3) How do the amphibian diversity and numbers compare to other, more natural, wetlands? 4) As the constructed wetlands age, how will the amphibian community respond?

This report summarizes our amphibian and vegetation sampling at the H-02 treatment wetlands from May 2008 to November 2009. We used permanent plots established for vegetation monitoring and aquatic trapping to characterize biota of the treatment wetlands. Adjacent drift fence arrays with pitfall traps were used to estimate breeding amphibian numbers and juvenile production (Fig. 1). In addition to monitoring amphibian and reptile use of the wetlands, we collected data on metal burdens of amphibians inhabiting the wetlands, and we conducted preliminary field and laboratory tests on effects of Cu concentration on amphibian development in three species (the southern toad, *Bufo terrestris*, the eastern narrowmouth toad, *Gastrophryne carolinensis*, and the southern leopard frog, *Rana sphenoccephala*). Biotic samples were collected to determine copper and zinc burdens, and field and laboratory experiments were employed to assess metal effects.

To date we have recorded 2,972 captures of 27 amphibian and reptile species at the H-02 treatment wetlands, including successful production of juveniles by a total of 10 amphibian species. This level of reproductive success was higher than at the natural wetland reference site, which has a short hydroperiod and has dried early in each of the last two years. However, both juvenile and adult amphibians have elevated Cu and Zn levels at the H-02 site compared to reference wetlands; averaged across species, Cu and Zn levels in juvenile, sub-adult, and adult amphibians from reference sites averaged 7.3 and 70.9 ppm respectively, compared to 65.0 and 205.4 ppm in metamorphosed amphibians at the H-02 site. Laboratory and field experiments are continuing to better understand potential biological effects that these trace metals may have on common amphibian species. Egg and early hatchling survival of *R. sphenoccephala* was reduced at higher copper concentrations (50, 100 and 150 ppb) in two egg survivorship laboratory studies we conducted (Fig. 3). However, embryonic development for both *R. sphenoccephala* and *B. terrestris* in field experiments, treatment wetlands, and the retention pond appeared to be normal; we observed no difference in hatching among locations for either species.

Our vegetation sampling recorded 22 total species (or species groups) of vascular aquatic plants in the H-02 treatment cells – 18 in FY-08 and 16 in FY-09 (Fig. 4). Four species or species groups, *Cynodon dactylon*, *Hydrocotyle ranunculoides*, the combined *Lemna minor*/*Spirodela polyrrhiza*, and the planted *Schoenoplectus californicus* (giant bulrush) were ubiquitous, occurring in 20 or more plots (>83%) both years. Average density of the giant bulrush for each of the cells was 30-32 stems/m² in 2008, increasing to 40-48 stems/m² in 2009. Vegetation will continue to be monitored and compared from year to year; these data can also be compared with similar created wetland systems (e.g., the A-01 system) and natural wetlands on the SRS.

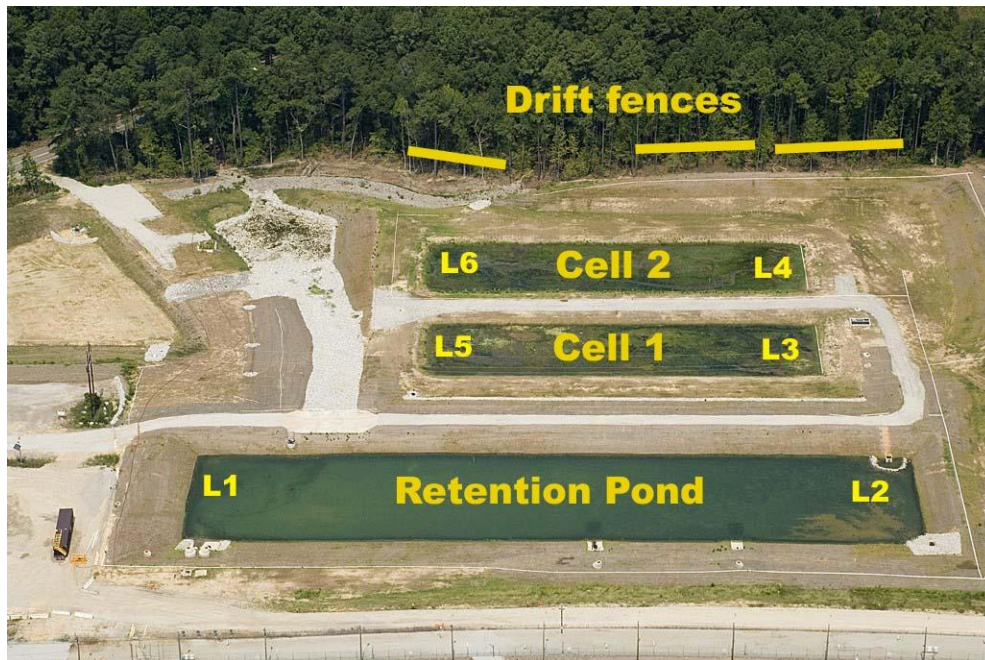


Figure 1. Drift fence/pitfall trap and egg/larval field experiment locations within the H-02 wetland system. Locations L1 & L2 (retention pond), L3 & L4 (influent end of wetland cells), and L5 & L6 (effluent end of wetland cells) represent a gradient of water chemistry along which the “bucket studies” have been conducted. Highest pH, Cu, and Zn levels occur in the retention pond, and progressively lessen throughout the treatment wetlands.



Figure 2. Floating bucket experiments used to examine the success of amphibian eggs and larvae in the H-02 system. Experiments to date have investigated the success of three species – narrowmouth toads, southern toads and southern leopard frogs – along the water chemistry gradient within the H-02 system. From left to right above – retention pond, wetland cell effluent end, and wetland cell influent end.

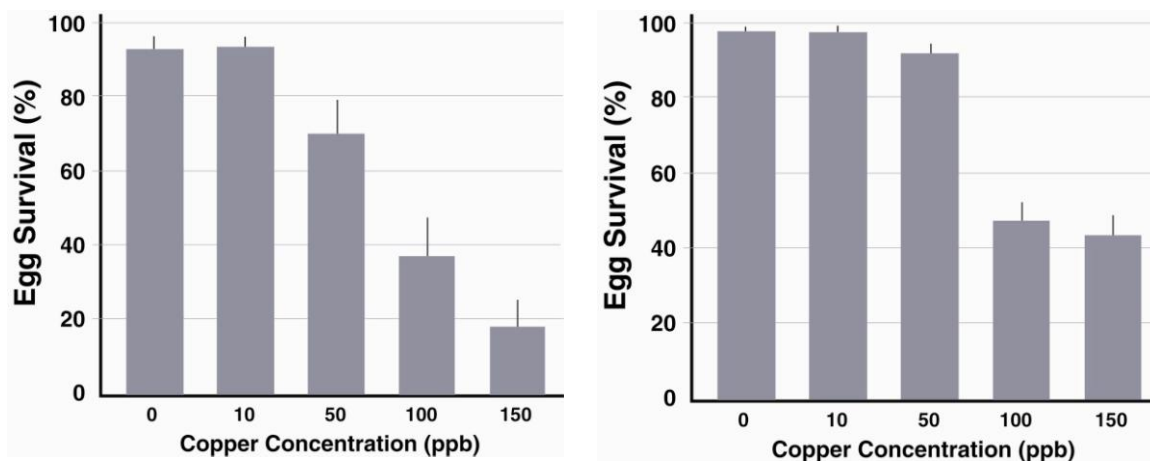


Figure 3. Egg survival of *R. sphenoccephala* at five copper concentrations; Trial #1 (left) and Trial #2 (right).

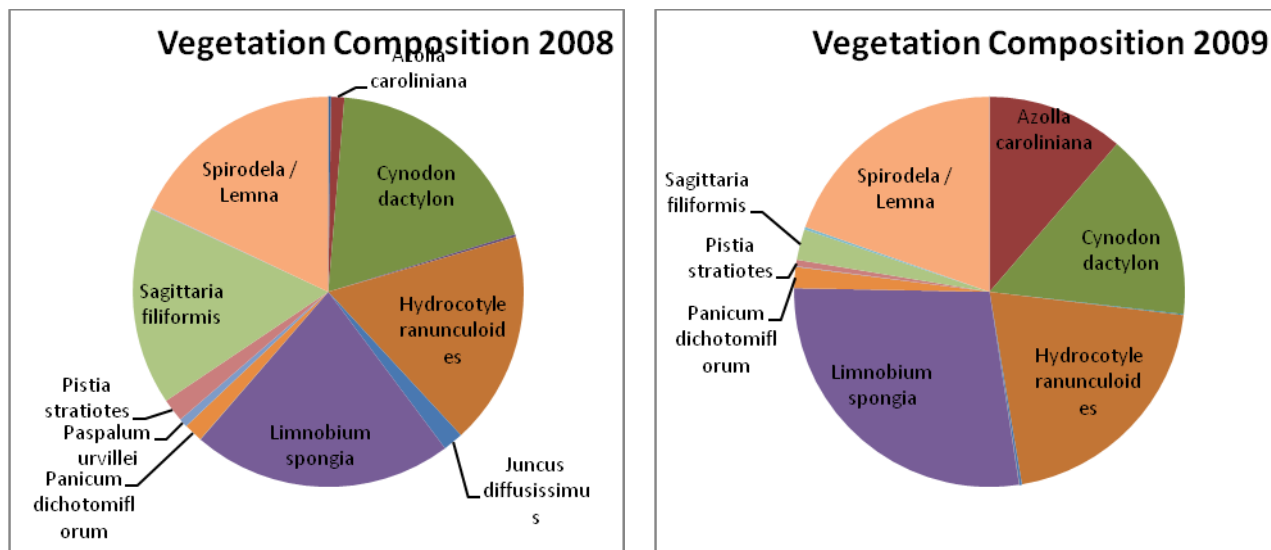


Fig. 4. Relative percent cover of dominant plant species in both H-02 wetland cells combined, exclusive of *Schoenoplectus californicus*.

We propose to continue studies on wetland plant community development and on focal amphibian species to better understand any water quality or contaminant thresholds that may negatively affect local populations. Because body burdens of trace elements acquired during the aquatic larval phase are retained through metamorphosis, these metals may be transferred from the wetland system (where they were acquired) into terrestrial food webs. This study will ultimately give us an understanding of how amphibians are an important pathway in trace element accumulation and elimination, and the extent to which they transfer metals from the H-02 wetlands to terrestrial food webs.

RESEARCH SUPPORT PROGRAMS

Several SREL programs provide critical support to the research, outreach, and education missions of the Laboratory. These support programs include:

- Environmental Health and Safety Program
- Quality Assurance Program
- Research Data Archive Activities
- SREL Undergraduate and Graduate Education Programs
- Environmental Outreach Program
- DOE Research Set-Aside Areas

Environmental Health and Safety (EH&S) Program

Donald R. Mosser, SREL EH&S Manager

The Savannah River Ecology Laboratory (SREL) continues to operate successfully under the work-smart safety and environmental standards that resulted from SREL's participation in U.S. Department of Energy's (DOE) Necessary and Sufficient process. These standards continue to address the hazards associated with SREL operations by permitting a focused effort on the health and safety issues most pertinent to SREL operations. SREL supports and promotes an integrated approach to SRS environmental health and safety issues as a signatory to the SRS Workplace Safety, Health and Security Policy and the SRS Environmental Management System Policy Statement.

SREL maintains a commitment of one, full-time position (SREL EH&S Manager) dedicated to the support of the SREL EH&S Program. Also several laboratory research technicians provide support to the SREL EH&S Program by serving as laboratory Chemical Coordinators. Chemical Coordinators are responsible for maintaining chemical inventory information and providing support in the identification, accumulation, and storage of hazardous wastes.

In an effort to increase the efficiency and effectiveness of the SREL EH&S Program, an emphasis continues to be placed on safety and environmental training of SREL personnel. All new SREL personnel receive a two-hour SREL-specific orientation on the topic of SREL safety and environmental programs, policies, and procedures in addition to the SRS required General Employee Training (GET). New SREL personnel also receive job specific safety training provided for by their SREL supervisor. Approximately 14 (fourteen) new SREL personnel received this required training during FY2009. Additionally, SREL personnel received EH&S related training during FY2009 in the following functional areas as their job tasks required:

- Chemical Coordinator Training – chemical inventories and hazardous waste generation and management
- Radiological Training – Radiological Worker Training, Radioactive Sealed Source User Training, and Radiation Generating Device training
- Remote worker training in accordance with SRS remote worker requirements
- Hazardous Waste Management (RCRA) Training for workers responsible for handling or storage of hazardous wastes
- Georgia Right-To-Know Law (GRTK- HAZCOM equivalent) chemical specific training for UGA/SREL employees who utilize hazardous chemicals in the work place

The SREL EH&S Manager functions as an interface with other SRS organizations in receiving and distributing applicable Lessons Learned information. By integrating with other SRS organizations to share Lessons Learned information, SREL takes advantage of the collective experience and improvements identified by other organizations for similar work processes and controls at SREL. SREL's internal computer network was used to provide targeted safety information to specific groups in the laboratory. The SREL EH&S Manager electronically distributed 25 (twenty-five) lessons learned notices in FY 2009 to targeted groups at SREL. Additionally, the SREL EH&S Manager electronically communicated approximately 100 SRS operational safety and environmental related announcements and notices to all SREL personnel.

The SREL EH&S Manager also interfaces with other SRS Contractor Environmental Health and Safety Programs and Professionals through participation in site level management Committees (ISM Integration Council and the SRS Senior Environmental Managers Council).

SREL waste minimization and chemical disposal issues continue to be emphasized to increase efficiency and cost effectiveness. Waste minimization techniques such as source reduction and bench-top treatment continue to be incorporated into experimental protocols, reducing the burden associated with waste disposal procedures while supporting SREL's pollution prevention efforts. SREL generated very small amounts of hazardous wastes in FY09 with a single hazardous waste shipment occurring during FY09, which was generated from closure of its B-Area Laboratory (772-25B). As part of SREL waste minimization efforts and to ensure that chemical hazards are addressed prior to purchasing chemicals, the SREL EH&S Manager reviewed and approved 68 purchase requisitions that included chemicals purchased by SREL personnel.

As a result of SREL staff and operational reductions during FY07, SREL had identified three B-Area facilities that were no longer required for continuing SREL operations. Effective January, 2009 SREL had successfully decommissioned and turned over its B-Area laboratory facility (772-25B) to Savannah River National Laboratory (SRNL) for their continued use of the facility as a laboratory-based research facility to support their current and future projects. SREL's remaining two facilities (772-26B and 772-27B) in B-Area have been appropriately identified as available to all other SRS Entities for potential transfer. All hazardous chemicals have been removed from these two remaining facilities and SREL anticipates transfer of these facilities during FY10 to other site contractors or entities for continued use. Alternatively, the facilities will be identified for consideration and inclusion in the SRS D&D lists.

The SREL EH&S Manager provided weekly reports of recordable personnel accidents or injuries to DOE-SR line management. SREL also provided monthly, SREL personnel work hour statistics to DOE-SR. SREL personnel reported 0 (zero) work related injuries/illnesses during FY09.

SREL received no Notices of Violation in FY09 as the result of external or internal reviews, inspections, or assessments. SREL conducted assessments in the areas of chemical and radiological air emissions, community right-to-know, and the Georgia Right-to-Know law in compliance with state and federal requirements. SREL also participated in the SRS's annual, comprehensive review and declaration process for Integrated Safety Management Systems (ISMS). As part of the annual ISMS declaration, SREL revised its Integrated Safety Management System Description Document, reviewed its FY08 safety performance, and established its FY10 safety performance goals.

Quality Assurance Program

The Quality Assurance Program is devoted to assuring the continued quality of research data. SREL "Good Research Practices" highlight research concepts and context, research logistics, and the conduct of research and are available to all SREL personnel. SREL has attempted to maintain this U.S. Department of Energy (DOE)-approved Quality Assurance (QA) program in the face of declining DOE budgets.

Research Data Archive Activities

Responsible management of research data plays an important role in preserving the SREL's institutional memory. SREL built a centralized repository of research data files and associated "metadata" necessary to make these data fully accessible. Goals of SREL's Research Data Archive activity are to avoid the inadvertent loss of data and to use advanced electronic computer/communication technology, including the use of computer networks and the Internet, to provide access to important data as efficiently as possible. A web-based SREL data archive system allows users to upload metadata information and actual data files directly from their office desktop computers. Anyone at SREL or on the SRS can search for data using this web-based system; however, decisions about releasing original data to third parties are retained by the principal investigators. A computer security issue reduced our ability to interactively access this system. While the computer files still exist, they are not as conveniently linked and searchable as before and retrieval of these data would be quite time consuming. SREL has been attempting to obtain funding to return these data archive files to their previous condition, without any success in FY09.

SREL Undergraduate and Graduate Education Program

Gary Mills

Objectives of the SREL Education Program are to (1) recruit and develop additional professionals to the environmental sciences and (2) enhance environmental awareness and research opportunities among undergraduate and graduate students with emphasis on conducting ecological research important to the DOE and Savannah River Site mission. We have made special efforts in the recruitment from under-represented minority groups and our faculty has worked with both students and faculty from Historically Black Colleges and Universities (HBCU) throughout the Southeast.

SREL has a long history of graduate and undergraduate education, training over 400 graduate and over 600 undergraduate researchers since 1967. Undergraduate students from more than 275 different colleges and universities have coauthored more than 170 peer reviewed research publications and more than 200 of these students have gone on to pursue careers in science. SREL offers students state-of-the-science laboratory facilities, a wide variety of natural and impacted habitats for field research, a diversity of faculty expertise, and more than fifty years of experience in ecological research. Since 1967, an average of six students per year has completed graduate studies at SREL, resulting in a total of more than 335 dissertations and theses. Since 1985, our graduate students have won over 200 awards from regional, national, and international competitions at numerous professional societies and foundations.

During the past year, SREL graduate students continued to compete successfully for various national and regional awards. Some of these are listed in the section on Special Accomplishments. Undergraduate and graduate student participants in FY09 are listed in Tables 1 and 2, respectively. During FY09, three Ph.D. and two M.S. students completed their degree requirements (Table 3). In recent years, SREL has undergone significant changes in administrative infrastructure and transitioned to self-supporting funding model. Throughout this transition period, SREL has maintained its commitment to student research and education as an integral component of its mission. In fact, six of the current graduate students initiated their program of study in 2009.

In addition to the laboratory's formal program in graduate and undergraduate education, SREL faculty and staff assist students and their faculty mentors at several universities and Savannah River National Lab in various activities in less formal relationships. This includes access to field sites, use of field equipment, temporary lab space, as well as analytical and GIS resources for their studies. Some of these activities are highlighted in Table 4.

Table 1. SREL Undergraduate Student Program Participants, FY 09

<u>Student</u>	<u>Academic Institution</u>	<u>Faculty Advisor/Supervisor</u>
Bess Harris	Agnes Scott College	T. Tuberville/ I. L. Brisbin
Annie Whitley	University of South Carolina, Aiken	G. Mills / M. Harmon
Traci Jones	Tennessee Technological University	G. Mills

Table 2. SREL Graduate Student Program Participants, FY 09

<u>Student</u>	<u>Degree</u>	<u>Institution</u>	<u>Faculty Advisor</u>
Kimberly Andrews	Ph.D.	University of Georgia, Athens	J. W. Gibbons
Shea Beuttner	M.S	University of Georgia, Athens	J. C. Seaman
Matt Bruns	M.S.	University of Georgia, Athens	J.C. Seaman
Wendy Bruns	M.S.	University of Georgia, Athens	J.C. Seaman
Elizabeth Burgess	Ph.D.	University of Georgia, Athens	G. Mills/J. Wiegel
Brian Crawford	Ph.D.	University of Georgia, Athens	T. Tuberville
Jaclin DuRant	M.S.	University of Georgia, Athens	R. R. Sharitz
Adam Hoffman	M. S.	University of South Carolina, Columbia	L. Newman
Larchinee Turner	M.S.	University of Georgia, Athens	J. C. Seaman
Brian Metts	Ph.D.	University of Georgia, Athens	K. Buhlman
Julian Singer	Ph.D.	University of Georgia, Athens	J. C. Seaman
Brian Todd	Ph.D.	University of Georgia, Athens	J. W. Gibbons
John Wilson	Ph.D.	University of Georgia, Athens	J. W. Gibbons

Table 3. SREL Graduate Students Completing Degree Requirements in FY09

Jaclin DuRant	M.S.	University of Georgia, Athens	R. R. Sharitz
Frantisek Majs	Ph.D.	University of Georgia, Athens	J. C. Seaman/W. Miller
Lucas Odum	M.S.	University of South Carolina, Columbia	L. Newman
Brian Todd	Ph.D.	University of Georgia, Athens	J. W. Gibbons
John Wilson	Ph.D.	University of Georgia, Athens	J. W. Gibbons

Table 4. Other Faculty and Staff Activities Supporting Student Research and Training Activities in FY09

Kurt Buhlmann:

Brett Moule, Ph.D. student, Clemson University - committee member and assisted in design of field research site on restoration of longleaf pine habitats using prescribed fire, herbicides, and mechanical removal of vegetation.

Nathaniel Hilzinger, M.S. student, Central Arkansas University - advised on the design of turtle research project and provided turtle genetic samples from the SRS.

Steven Ecrement, M.S. student, Miami (Ohio) University - assisted in design of his radio telemetry study of Blandings turtles on Great Meadows National Wildlife Refuge, Massachusetts.

Joanna Rogers, undergraduate, Michigan State University - assisted in the design of her senior project to radio track Blandings turtles and determine winter hibernation sites on Shiawassee National Wildlife Refuge, Michigan.

George Cevera, undergraduate, Monmouth County Community College, New Jersey - assisted in his internship to radio track wood turtles on Great Swamp National Wildlife Refuge, New Jersey.

Robert Kenamer:

Collaborator on a NSF funded project with G. Hepp (Auburn U.) and W. Hopkins (Virginia Tech) project requires facilities, equipment, and office space provided by SREL. Field studies are conducted at PAR Pond and L-Lake on the SRS. This project is providing research and educational opportunities for 2 graduate students, Johnathan Walls (Auburn Univ.) and Sarah DuRant (Virginia Tech). Walls, along with two Auburn field technicians are stationed at SREL for 6 months per year working on the project. DuRant makes visits to SRS/SREL from Virginia Tech to assist in field work.

Gary Mills:

Jay Summers, M.S. student, Eastern Illinois University - advised on sample preparation and measurement of PCBs in clapper rail feathers.

Annie Whitley, B.S. student, University of South Carolina – Aiken - advised on senior research project assessing toxicity of effluent waters from the SRS Tritium Facility.

Benjamin Neely, Ph.D. student, Medical University of South Carolina - provided assistance in chemical analysis associated with research on the effects of U and Ni on the degradation of TCE by bacteria.

Caroline Johnson, B.S. student, University of South Carolina, summer intern at SRNL - provided lab space and training on the analysis of PCBs in SRS process wastes.

Tracey Tuberville:

Justin Henningsen, Ph.D. student, University of Massachusetts-Amherst - on-site sponsor for his dissertation research on SRS and residency at SREL.

Matthew Gordon, DVM student, Tufts University - mentor for summer field research project at St. Catherines Island, GA.

Joshua Ennen, Ph.D. student, University of Southern Mississippi - collected and shared turtle genetic samples from multiple populations for conservation genetics project.

Tom Luhring, Ph.D. student, University of Missouri - Columbia - facilitated continuation of his research on sirens on SRS.

Nathaniel Hilzinger, M.S. student, Central Arkansas University. Collected and sent turtle genetic samples from SRS for his research project.

Interacted with approximately 25 international wildlife veterinarian students by demonstrating reptile and amphibian capture techniques as part of training workshop. Workshop held at St. Catherines Island, GA.

Environmental Outreach Program

J. Whitfield Gibbons

GOAL: Maintain public outreach and communication programs to enhance the public's understanding of environmental issues affecting the SRS and to increase general ecological awareness.

The Savannah River Ecology Laboratory (SREL) Outreach Program uses information from SREL research efforts to educate the public locally, regionally, and nationally. The Outreach Program is designed to enhance SREL's overall mission of acquiring and communicating environmental knowledge and to highlight NNSA's and the U.S. Department of Energy's (DOE) focus on environmental issues on the SRS. Issues as diverse as amphibian and reptile population declines, potential responses of organisms to contamination, distribution and abundance of sensitive species, and dispersal of organisms from radioactively or chemically contaminated sites all are important beyond SREL. Public education during FY08, especially for K-12 audiences, was accomplished through a variety of programs and materials funded predominately from NNSA MOX.

During the past year SREL, scheduled and completed the following:

1. On-site and in-classroom education programs for elementary and secondary students. NUMBER OF TALKS – 220; ESTIMATED NUMBER OF ATTENDEES – 12,371.

2. Presentations to school, civic, and professional groups. NUMBER OF TALKS – 49; ESTIMATED NUMBER OF ATTENDEES – 3,507.

3. Exhibits at local and regional events; NUMBER OF EXHIBITS – 15; ESTIMATED NUMBER OF ATTENDEES – 13,798.

4. Regularly scheduled public tours. NUMBER OF TOURS – 18; ESTIMATED NUMBER OF ATTENDEES – 190.

Total events: 302; Total estimated attendance: 29,866

Topics for these presentations included reptiles, amphibians, southeastern plants and habitats, long-term research, safety, biodiversity, local wetlands and watersheds, conservation, and careers in ecology and research. In addition, a total of 834 students from 17 schools enjoyed field trips to SREL's Conference Center to participate in the Ecologist-for-a-Day program.

Outreach programs include: *Ecotalk*, an opportunity for students to have nature brought into their classroom for a face-to-face lesson on a variety of live animals found in local habitats; *Ecologist for a Day* visits allow students to spend the day in the field gaining hands-on

knowledge of the plants and animals of the unique Upper Three Runs Creek area; civic group presentations; and ecological tours. All school programs incorporate science standards and curricula for particular school districts. In many of these programs participants get an opportunity to work with SREL staff as they catch, mark, and measure various species of reptiles, amphibians, fish, small mammals, and invertebrates. In addition, the Outreach Program offers tours of SREL facilities, as well as exhibits and workshops for the general public.

The main SREL Outreach site receives numerous hits, as it has links to the popular *Ecologist for a Day* program, Outreach fact sheets and products, and the Ecoviews newspaper column. SREL also continues the website for *Kids Do Science* that provides all the necessary materials for 10 hands-on activities developed as part of the hands-on science program with the American Honda Foundation. This site is frequented by teachers from throughout the country who use the materials in their own classes.

SREL distributes thousands of copies of educational products and materials nationwide to schools, organizations, and the general public. Educational materials include two six-foot-long full-color posters describing the importance of wetlands to reptiles and amphibians, along with teachers' guides. The full-color brochure *Snakes of Georgia and South Carolina* (currently in its fifth printing) has proved to be an extremely successful educational product that reflects positively on DOE and the SRS. The book has been placed at no charge in every public library in Georgia and South Carolina and is also widely distributed at no cost to hospital emergency rooms, veterinary clinics, ambulance services, classrooms, scout leaders, and to various other organizations such as the Boys and Girls Clubs in Aiken and Augusta. Articles referencing the book have appeared in numerous newspapers and magazines including publications in Florida and Texas.

The Outreach Program also continued to distribute educational materials including fliers on *Carnivorous Plants and Their Habitats*; the national version of the Partners in Amphibian and Reptile Conservation (PARC) poster produced by SREL; the brochure *American Alligator* that discusses all safety, ecological, and conservation aspects of alligators; *An Amphibian's Eye View of Wetlands*; and *Is it a Water Moccasin?*; a children's comic book entitled *Stepping into Ecology: the Ecological Adventures of Mud E. Boot*; a sticker on *Chemistry – it's all about the nature of things*, and the *Metric System Rap* bookmark, as well as the numerous fact sheets available through the website. All of these products have been extremely popular and thousands of copies have been distributed during the past year. Previously created full-color fact sheets and research "snapshots" on a wide variety of research topics were distributed as well. The SREL copies of *Carnivorous Plants and Their Habitats*, *American Alligator*, and the PARC poster are now depleted. Reprinting will be necessary to continue their distribution for educational purposes.

The Outreach Program continues to respond to inquiries from the press, directing reporters to the most appropriate researchers for their stories. In addition, SREL sends press releases to media contacts on a regular basis as well as submits research information to appropriate audiences. From 2008-2009 SREL researchers provided information to such diverse outlets as the SC Wildlife Magazine, Natural History Magazine, Riverbanks Zoo Magazine, and Reptiles Magazine as well as local news outlets in the Southeast such as *the Aiken Standard*, *Atlanta Journal-Constitution*, *Athens Banner-Herald*, *Augusta Chronicle*, *Bluffton Today*, *Charlotte Observer*, and *the State newspapers*. Topics in the news included: animal behavior, release protocols, preserving data sets, conservation, and SREL researcher profiles.

DOE Research Set-Aside Areas

Charles E. Davis

The SRS's Set-Aside Program began in the 1960s when the Atomic Energy Commission (AEC) established 10, relatively small *SREL Reserve Areas* to represent the various habitats on the SRP and to secure study sites for conducting long term ecological research. The Program was expanded in the 1980s to 30 *DOE Research Set-Aside Areas* to better protect sensitive species habitats, preserve the biological integrity of Upper Three Runs Creek, and to buffer SREL's long term research from encroaching forest management activities. These Areas are a significant component of the SRS landscape (7% of SRS totaling 14,560 acres/5,892 ha) and are found in 43 of the Site's 89 timber resource compartments. There are approximately 275 miles (443 km) of posted boundary line.

Set-Aside Areas are critical to the DOE's Environmental Stewardship mission: they provide for long term study sites as well as sanctuary and protection to much of the SRS's sensitive flora and fauna, including many archaeological sites. They also serve as benchmarks or baseline controls for conducting ecological risk assessments, contaminant transport studies, and site remediation and restoration work. They exist today in strong support of the SRS being a National Environmental Research Park.

Administration and Management of the Set-Aside Areas

Under the existing Cooperative Agreement with the DOE, SREL serves as the point of contact for the 30 Set-Asides and provides custodial oversight of the SRS Set-Aside Program. SREL chairs the DOE's Set-Aside Task Group which approves management prescriptions, evaluates proposed ecological research, and ensures protection from onsite land use activities. Since FY07, DOE funding support for this program has ceased. However, SREL continues the day-to-day administration of the program. Boundary maintenance and developing and implementing stewardship management plans no longer are conducted despite the need to implement management treatments in Set-Asides in order to maintain their ecological integrity and future research value. However, Site Use coordination and maintenance of research and GIS databases continues. Management treatments in the form of controlled fire or silvicultural thinnings are prescribed for timber stands/vegetation types in various Set-Aside Areas in order to recreate overstocked plantation pine into a healthier, more natural plant community that is more suitable to the soil and less likely to attract beetle infestation. It also reduces the potential for a damaging wildfire by reducing the fuel build up.

Accomplishments and maintenance activities for the Set-Aside program for FY09

- The Set-Aside Task Group met formally one time to get an administrative update and to address issues concerning Set-Asides.
- The one timber thinning treatment for the Dry Bay Set-Aside remains pending and unscheduled.
- The Craig's Pond Scientific Advisory again this year requested a prescribed growing season burn for Craig Pond (Set-Aside Area No. 17). SREL worked in cooperation with the USFS-SR and Energy Solutions to accomplish an early summer burn treatment rather than the requested early spring burn. In addition, the SCDNR formally requested from the DOE-SR the acquisition of the Craig Pond/Sarracenia Bay Set-Aside so that the entire Craig Pond area could be owned and managed as DNR's Heritage Preserve and Wildlife Management Area for public recreation

and hunting. At this point, the DOE-SR management has not formally requested a response from the Set-Aside Task Group.

- SREL released an updated version of the Set-Aside GIS boundary layer to the SRNS PGSE Group to reflect administrative boundary changes. SREL received the LIDAR data flown for the SRS and determined that the GIS boundary line for the Set-Asides could be greatly improved when overlaying and comparing to surface disturbance features shown in the LIDAR imagery.
- Prescribed winter season burning coordination continued between SREL and the USFS-SR to minimize potential impacts to Set-Asides. When burning TC 34, the Set-Aside Task Group agreed to allow the USFS-SR to burn through the entire Risher Pond Set-Aside Area.
- Members of the Set-Aside Task Group continued to address erosion impact issues to Area No. 30 (Reedy Branch area) that were associated with WSI/DOE authorizing timber removal that was to provide a vegetative buffer to the expansion of the ATTA range.
- SREL cleared interferences for 66 Site Use Permits for potential impacts to the Set-Aside Areas and applied for one new permit this FY. SREL provided comments on DOE NEPA documents which included potential impacts to Set-Asides from the ATTA Range expansion, US Military training maneuvers, and the site of a Biomass power plant. SREL attended one meeting and workshop with the US Army to discuss potential impacts from proposed training activities on Set-Aside Areas.
- No acreage was added or deleted from the program this FY, nor was there any boundary line marking performed for boundary changes added in FY09.

Research and Outreach in Set-Aside Areas

- Long-term research continued in Set-Aside Areas this FY using traditional study sites and reference sites for collections of uncontaminated plants, animals, soils, or water. SREL produced seven publications that used Set-Asides with an overwhelming majority of these devoted to amphibian research in depressional wetland Set-Asides.
- SREL completed its 32nd year of daily sampling of the Rainbow Bay Set-Aside, the longest continuous amphibian study in the world, while Ginger's Bay Set-Aside continued its seasonal sampling which has been ongoing for 24 continuous years. These and other long-term data coming from studies in Set-Asides continue to be used to better understand survival patterns and population dynamics of southeastern herpetofauna. Studies continued on the effects of the chytrid fungus which has been reported on the SRS from several locales, which may yield an understanding of the factors that drive population size variation, especially with climate change predictions. Coupled with this, select amphibian species at a number of Carolina bay Set Asides continued to be sampled to help determine how genetically isolated populations are from one another. Combined with estimates of terrestrial distributions and movements of salamanders from the Ginger's Bay Set Aside, these site-wide genetic data will allow researchers to model connections among wetlands and the likelihood of recovery from local extinctions.
- Studies continued to be conducted in the Steel Creek and Dry Bay Set-Asides where aquatic vertebrates and invertebrates were sampled to examine seasonal activity levels. Tissue samples were collected from greater sirens for use in population genetics and for the development of a sex-linked marker. Also in Dry Bay, a mark-recapture population analysis continued to be conducted on greater sirens and two-toed amphiumas using PIT tags. This study examined the distribution of species and individuals among microhabitats and depth levels in the bay and focused on the ability of these species to sense and respond to chemical cues from predators.
- Also, SREL researchers continue to examine the role of prey availability, prey type, and environmental stochasticity on aquatic snakes (primarily *Nerodia* and *Seminatrix*) at the level of the individual, population and community at Ellenton Bay and other wetland Set-Aside Areas.

Long-term monitoring of these aquatic snake populations and their community dynamics will aid in understanding their response to environmental variation (drought) and amphibian prey availability. In addition, Ellenton Bay is sampled monthly as a comparison site for the projects being conducted at the D-Area Ash Plume Wetland and the H-02 constructed wetland.

- The vegetation study in the Field 3-412 Set-Aside continued this FY. This study is part of a cross-latitude experimental network examining the effects of climate change on old field vegetation succession across the Eastern US. Data gathered from this study will aid researchers in assessing important controls on the rates of woody succession and in the development of predictive climate change models.
- DOE-HQ funded SREL to conduct a biodiversity study in the UTRC Set-Aside (Area No. 30) to determine the current status of its water quality and aquatic insect life and to assess the effects of SRS operations on these watershed resources.
- SREL and SRNL collaborated on a SERDP grant that uses Set-Aside streams to develop ecological reference models and an assessment framework for other southeastern coastal plain stream systems common to the DOD's military reservations.
- The USFS-SR initiated a rare plant survey on the SRS to include the Set-Aside Areas.
- Archaeologists with the USC-Savannah River Archaeologist Research Program continued their investigations examining the occupational use of the Flamingo Bay sand rim. Ground penetration radar was used to understand subsurface features and rim and basin morphology.
- The NRCS used the Craig Pond Set-Aside (Area No. 17) as a reference bay wetland for comparison to a farmed Carolina bay wetland restoration program in nearby Bamberg County.
- Several Set-Aside Bay wetlands are being used for sampling of zooplankton in collaborations with North Carolina State University and the USFS-SR examining how terrestrial habitat connectivity affects the spread of plankton and community dynamics in ongoing corridor studies.
- The USFS-SR in collaboration with UGA scientists installed a flow weir in the Rainbow Bay Set-Aside to evaluate the watershed effects of upstream timber harvests on riparian habitats and water quality.
- As part of the ACP's Stream Restoration Baseline Project, SREL worked with the USFS-SR and University of Kentucky to continue its stream characterization in the UTRC/Tinker Creek (Set-Aside Area No. 30) and Meyers Branch (Set-Aside Area No. 11) drainages for making recommendations to future DOE restoration and mitigation efforts.
- SREL's Outreach program continued to focus on the E. P Odum Wetland (UTRC) when conducting Ecologist For a Day at the UGA Conference Center. This program conducts field studies with local school groups where participating students are able to use ecological research techniques to experience the biodiversity associated with the surrounding habitats of UTRC. The purpose of these outdoor classroom studies is to enhance environmental awareness about the UTRC watershed, to promote environmental stewardship, and to encourage students to consider careers in the sciences.

Program Needs Include:

- No Set-Aside management plans were worked on this year. No prescribed stand treatments were implemented.
- The pine beetle infestation in an ice damaged stand slated for regeneration and conversion to a longleaf/wiregrass community in the Flamingo Bay Set-Aside (Areas No. 21) was recommended for harvest has not seen further infestation and mortality. The stand should be examined in FY10 as well as the pine stand that was thinned in recent years.
- The Site Use Permit for the Set-Aside Areas remains in need of amendment updates to reflect changes to the administrative boundaries for the Set-Aside Areas No's 3, 11, 12, 24, 29, and 30. Following Site Use approval, area additions will require new boundary postings.

Externally Funded Grants

PI	Carl Bergmann
Project Title	CRAWDAD Maritime Test Campaign
Funding Agency	Savannah River National Laboratory
Period	June 1, 2008 — October 31, 2008
Budget	\$80,000
PI	I. Lehr Brisbin
Project Title	Ecological Studies of Birds In The Vicinity of the Augusta Regional Airport at Bush Field and the Messerly Wastewater Treatment Plant
Funding Agency	Augusta Richmond County Consolidated Government
Period	October 1, 2007 – December 31, 2008
Budget	\$63,875
PI	I. Lehr Brisbin
Project Title	Ecological Studies of Birds In The Vicinity of the Augusta Regional Airport at Bush Field and the Messerly Wastewater Treatment Plant
Funding Agency	Augusta Richmond County Consolidated Government
Period	January 2009 – September 30, 2009
Budget	\$75,039
PI	I. Lehr Brisbin
Project Title	UGA Foundation Canine Research
Funding Agency	UGA Foundation
Period	Open
Budget	\$28,505
PI	Larry Bryan
Project Title	Determination of Wood Stork Breeding Success in Georgia
Funding Agency	U.S. Department of the Interior-FWS
Period	April 1, 2004 — June 30, 2009
Budget	\$46,666
PI	Larry Bryan
Project Title	Determination of Wood Stork Colony Breeding Success on Kings Bay Naval Submarine Base
Funding Agency	U.S. Department of the Interior-USFWS
Period	March 1, 2004 — September 30, 2009
Budget	\$8,414
PI	Larry Bryan
Project Title	Determination of Core Foraging Areas for Wood Stork Nesting Colonies in Northern Florida
Funding Agency	U.S. Department of the Interior-USFWS
Period	March 1, 2004 — September 30, 2009
Budget	\$30,000

PI	Larry Bryan
Project Title	Wood Stork Foraging Habitat Assessment for Southwest Florida
Funding Agency	National Audubon Society
Period	June 1, 2007 — September 30, 2009
Budget	\$7,200
PI	Larry Bryan
Project Title	Determination of Wood Stork Colony Breeding Success in Georgia and South Carolina in 2007
Funding Agency	U.S. Department of the Interior-USFWS
Period	April 1, 2004 — September 20, 2009
Budget	\$8,496
PI	Larry Bryan
Project Title	Support of the SRS Trophic Transfer Modeling Effort
Funding Agency	Savannah River Nuclear Solutions – ACP
Period	October 1, 2008 — September 30, 2009
Budget	\$85,000
PI	Kurt Buhlmann
Project Title	Development of Amphibian Monitoring Methodologies for the Gulf Coast Network (CESU) Phase 3
Funding Agency	CESU – Piedmont
Period	October 2008 – September 30, 2009
Budget	\$54,500
PI	Charles Davis
Project Title	Deer Forage Assessment of Upper Steel Creek Area
Funding Agency	Savannah River Nuclear Solutions – ACP
Period	October 1, 2007 — September 30, 2009
Budget	\$43,440
PI	Charles Davis
Project Title	Wildlife Literature Survey and GIS Database Update
Funding Agency	Savannah River Nuclear Solutions – ACP
Period	October 1, 2008 — September 30, 2009
Budget	\$37,000
PI	Charles Davis
Project Title	Seasonal Remote and Field Reconnaissance of the Lower Three Runs Creek Corridor
Funding Agency	Savannah River Nuclear Solutions – ACP
Period	October 1, 2008 — September 30, 2009
Budget	\$47,000

PI	Dean Fletcher
Project Title	Enhancement of Disturbed Upper Coastal Plain Stream Systems: Establishing Restoration Criteria and Strategies for a Stream Mitigation Bank
Funding Agency	University of Kentucky-U.S. Forest Service
Period	February 1, 2006 — September 30, 2009
Budget	\$58,737
PI	Whit Gibbons
Project Title	Land Use Practices and Persistence of Amphibian Populations
Funding Agency	National Science Foundation
Period	May 15, 2003 — April 30, 2009
Budget	\$283,452
PI	Whit Gibbons
Project Title	Wildlife Highway Crossing Study: Investigation of the Use of Highway Culverts by Wildlife
Funding Agency	U.S. Department of the Interior-USGS
Period	February 17, 2006 — March 31, 2009
Budget	\$74,939
PI	Whit Gibbons
Project Title	Website Maintenance and Scientific Oversight of the North American Reporting Center for Amphibian Malformations (NARCAM)
Funding Agency	US Department of Interior (USGS)
Period	September 2008 – March 31, 2009
Budget	\$30,000
PI	Whit Gibbons
Project Title	Investigating Effects of Ecologically Conservative Residential Development on Snake Movement Patterns and Survivorship
Funding Agency	Palmetto Bluff Conservancy
Period	April 1, 2006 — March 30, 2009
Budget	\$34,006
PI	Whit Gibbons
Project Title	Incidence of Chytrid Fungal Parasitism in Southeastern Parks
Funding Agency	Cooperative Ecosystem Studies Unit-Piedmont
Period	May 1, 2006 — December 30, 2008
Budget	\$31,243
PI	Whit Gibbons
Project Title	Public Outreach Activities
Funding Agency	Department of Energy-NNSA (MOX)
Period	October 1, 2008 — September 30, 2009
Budget	\$200,000

PI	Whit Gibbons
Project Title	Public Outreach Activities
Funding Agency	Department of Energy-NNSA (Tritium)
Period	October 1, 2008 — September 30, 2009
Budget	\$100,000
PI	Tom Hinton
Project Title	C14 Research Used in SRS Composite Analysis
Funding Agency	Washington Savannah River Company
Period	March 11, 2008 — November 30, 2008
Budget	\$59,993
PI	Tom Hinton
Project Title	Transgeneration Effects from Chronic Low-Dose Irradiation in a Medaka Fish Model System
Funding Agency	Colorado State University-DOE
Period	July 1, 2005 — December 31, 2008
Budget	\$318,874
PI	Tom Hinton
Project Title	Estimation of Radioactive Contamination of Media and Terrestrial Biota at the Territories Adjoining Chernobyl NPP's Cooling Pond
Funding Agency	Civilian Research and Development Foundation
Period	August 1, 2007 — July 31, 2009
Budget	\$4,500
PI	Robert Kenamer
Project Title	Cost of Incubation: Linking Incubation – Induced Alteration in Phenotype to Changes in Fitness
Funding Agency	VA Polytechnic Institute
Period	October 1, 2008 – August 31, 2009
Budget	\$16,749
PI	Robert Kenamer
Project Title	Aerial Surveys of Wintering Waterfowl at Lake Murray, SC
Funding Agency	Kleinschmidt Associates
Period	October 1, 2007 — February 28, 2009
Budget	\$4,467
PI	J Vaun McArthur
Project Title	Baseline Studies of Water and Soil Quality, Aquatic Macroinvertebrates Communities and Vegetation in an Area Adjacent to the MOX Fuel Fabrication Facility Construction Site
Funding Agency	Department of Energy-NNSA
Period	October 1, 2008 — September 30, 2009
Budget	\$220,000

PI	J Vaun McArthur
Project Title	Environmental Protection of DOE Lands: Studies in Long-Term Stewardship
Funding Agency	US Department of Energy
Period	August 15, 2008 — September 30, 2009
Budget	\$100,000
PI	Gary Mills
Project Title	Impact of Proposed MOX Facility Effluent Discharges to Upper Three Runs Creek Watershed
Funding Agency	Department of Energy-NNSA
Period	October 1, 2008 — September 30, 2009
Budget	\$80,000
PI	Gary Mills
Project Title	H-02 Constructed Wetland Studies
Funding Agency	Department of Energy-NNSA
Period	October 1, 2008 — September 30, 2009
Budget	\$250,000
PI	Christopher Romanek
Project Title	Holocene Shell Accumulation from the Southeast Brazilian Bight: Multi-Centennial Dynamics of Oceanographic, Environmental, and Ecological Changes
Funding Agency	National Science Foundation
Period	July 1, 2006 — June 30, 2009
Budget	\$94,776
PI	Christopher Romanek
Project Title	Optical Microscopy and Chemical Analysis for Crystal and Liquid Samples
Funding Agency	Savannah River National Laboratory
Period	March 4, 2008 — February 12, 2009
Budget	\$60,500
PI	Christopher Romanek
Project Title	Polarized Light Microscopy (PLM) and Chemical Analysis
Funding Agency	Savannah River Nuclear Solutions
Period	February 2009 – September 30, 2009
Budget	\$51,150
PI	John Seaman
Project Title	Tritium Distribution at the Tritiated Water Management Facility
Funding Agency	Savannah River Nuclear Solutions – ACP
Period	October 1, 2008 — September 30, 2009
Budget	\$112,000

PI	John Seaman
Project Title	In-Situ Chemical Oxidation (ISCO) to Address Residual TCE and PCE Contamination on the Savannah River Site
Funding Agency	Savannah River National Laboratory
Period	August 1, 2008 — September 30, 2009
Budget	\$75,325
PI	John Seaman
Project Title	Survey of Environmental Monitoring Techniques for Application to DOE Analysis and Monitoring Needs
Funding Agency	Department of Energy-NNSA
Period	October 1, 2007 — November 30, 2009
Budget	\$60,000
PI	John Seaman
Project Title	Development of Characterization Methodologies for Environmental Nano-Particles
Funding Agency	Savannah River Nuclear Solutions – ACP
Period	August 18, 2008 — November 30, 2009
Budget	\$15,092
PI	John Seaman
Project Title	Cavity Ring Down Spectroscopy: Proof of Concept for Environmental Analysis and Monitoring of Process Systems at DOE's Savannah River Site
Funding Agency	Department of Energy - NNSA
Period	August 1, 2008 — September 30, 2009
Budget	\$190,000
PI	John Seaman
Project Title	Molecular Mechanisms of Bacterial Attachments to Fe(III)-Oxide Surfaces
Funding Agency	US Department of Energy
Period	September 15, 2005 — September 14, 2009
Budget	\$684,403
PI	John Seaman
Project Title	Improved Modeling of Inorganic Contaminant Transport in the Vadose Zone: A Defensible Basis for MN/EA
Funding Agency	US Department of Energy
Period	August 15, 2008 — September 30, 2009
Budget	\$100,000
PI	John Seaman
Project Title	Iodine - 129 Behavior in Wetlands
Funding Agency	Savannah River Nuclear Solutions
Period	February 2009 – September 30, 2009
Budget	\$29,976

PI	Rebecca Sharitz
Project Title	On-Site Field Studies and Long-Term Monitoring Required for BRAC Implementation, Environmental Compliance, Technology Integration Assistance...
Funding Agency	Cooperative Ecosystem Studies Unit-Gulf
Period	September 16, 2006 — November 30, 2009
Budget	\$362,889
PI	Tracey Tuberville
Project Title	Genetic Mating System of Translocated Gopher Tortoises
Funding Agency	Riverbanks Zoo
Period	June 1, 2008 — December 31, 2010
Budget	\$4,804
PI	Tracey Tuberville
Project Title	Using Individual Behavior-Based Modeling to Predict Population Response and Long-Term Viability of "Species At Risk"
Funding Agency	US Department of Army
Period	August 26, 2008 — November 31, 2009
Budget	\$76,749
PI	Tracey Tuberville
Project Title	H-02 Constructed Wetland Studies- Amphibians and Plants
Funding Agency	Department of Energy-NNSA
Period	October 1, 2008 — September 30, 2009
Budget	\$325,000
PI	Tracey Tuberville
Project Title	Assessing the Ecological Health of Stream Systems and Watersheds of SRS Ecosystems: Modeling the Herpetofaunal Habitat-Biodiversity Relationship
Funding Agency	Savannah River Nuclear Solutions – ACP
Period	October 1, 2008 — September 30, 2009
Budget	\$120,000

Publications

Journal Articles Published In FY2009 (publication with an asterisk were previously published but never assigned a SREL publication number)

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SREL Organizational Chart – FY09

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Donald R. Mosser

Computer Service and GIS Lab Manager

Joshua Dooley

Education Program

Gary L. Mills
Tracey Tuberville

Outreach Program

J. Whitfield Gibbons

Research and Facilities Technical Services

Mark Edwards
Malcolm Squires

Administrative Services

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(As of 10/1/2009)